



State University of New York  
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# Sugar maple canopy response to fertilizer



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## Introduction

Gradients created by canopy depth attenuate light. Vertical transects of fertilized trees enable the assessment of individual level variation of foliar characteristics through the vertical gradient of canopy depth. Light environment, vapor pressure deficit, and temperature are impacted by canopy depth.

We expect that trees will adjust photosynthetic pigment and amino acid concentrations in response to light environment and also when fertilized with Nitrogen. Similarly, we expect the physical structure of leaves to respond to Nitrogen fertilization, and be impacted by light environment.

To assess nutrient limitation of Sugar Maple in Northern hardwood forests we collected foliage from twelve mature sugar maple trees from three experimental stands in the White Mountains National Forest.

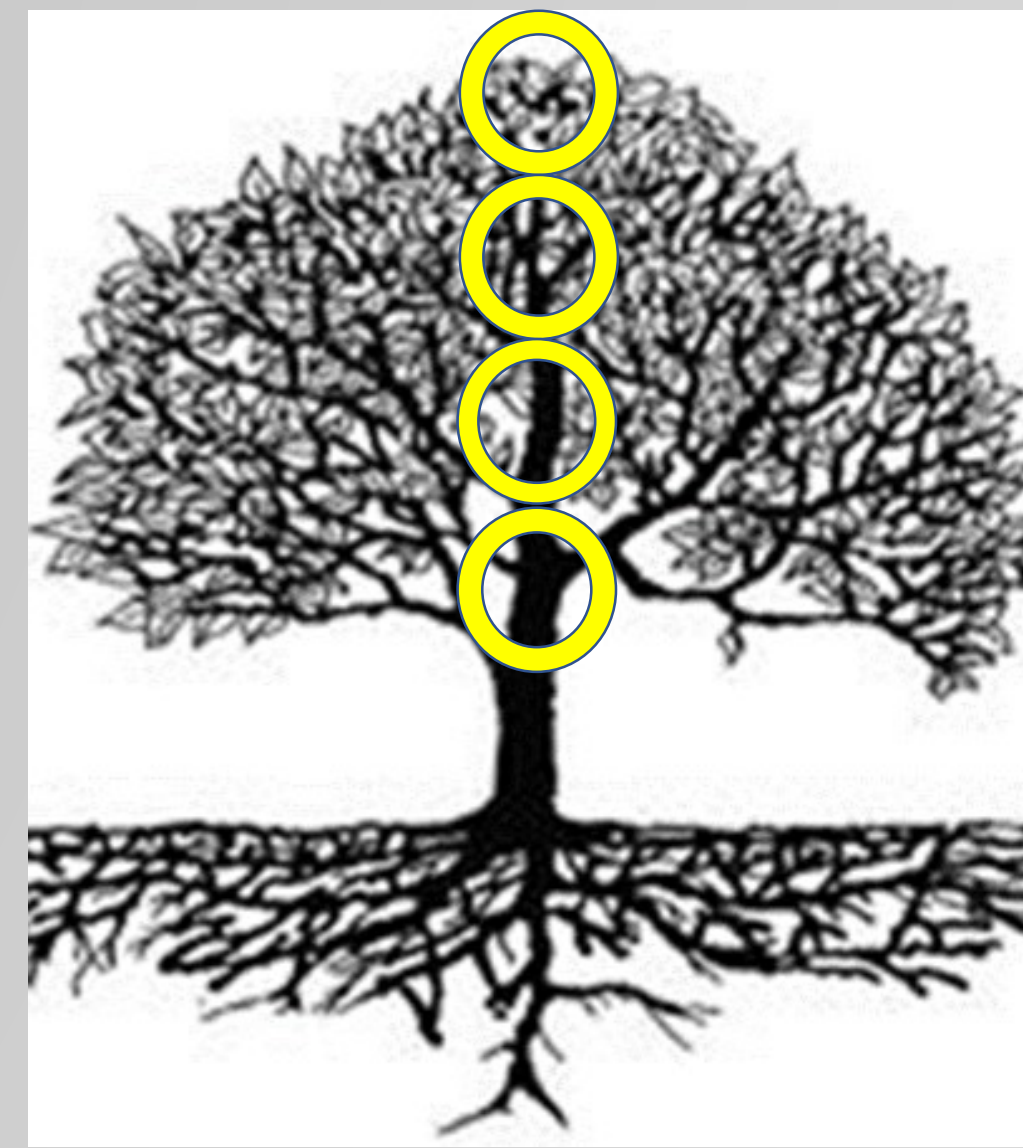
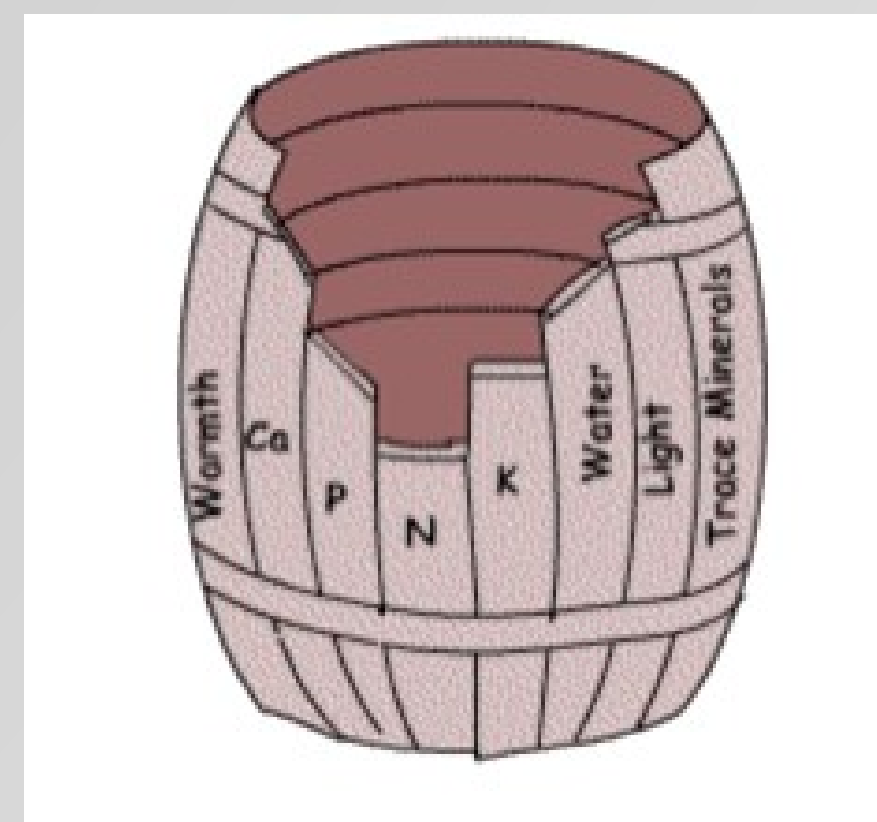
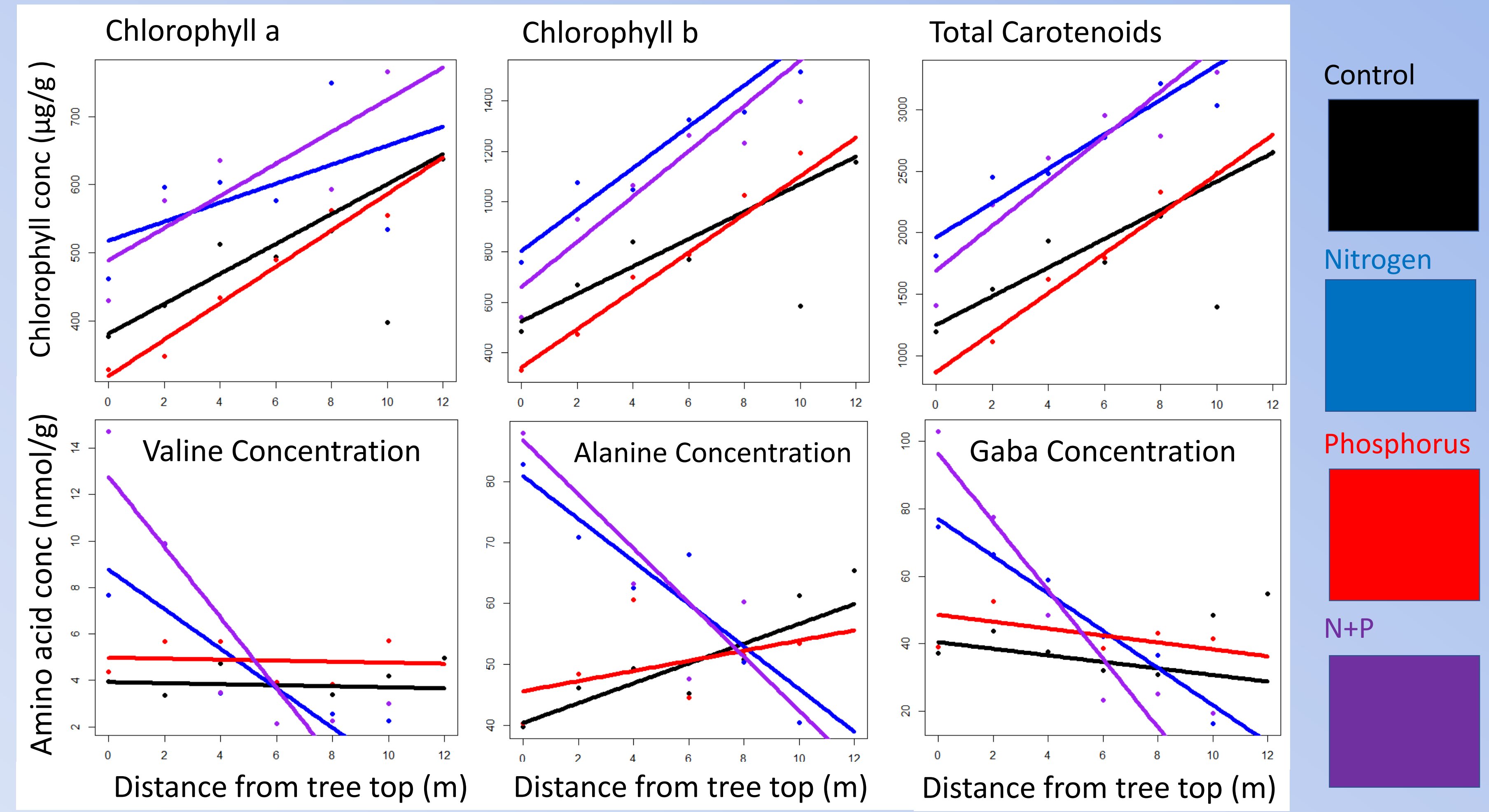


Diagram of vertical transect (above). Leibig's barrel represents a traditional view of nutrient limitation (below).



## Metabolite Results: Nitrogen Main effect



Photosynthetic pigments (chlorophyll a, b, and carotenoids) concentrations were higher in trees that received Nitrogen, but not phosphorus ( $p = 0.02$ ). Amino acids Valine, Alanine, and Gaba were higher in trees that received Nitrogen, but only at the top of the tree ( $p < 0.01$ ).

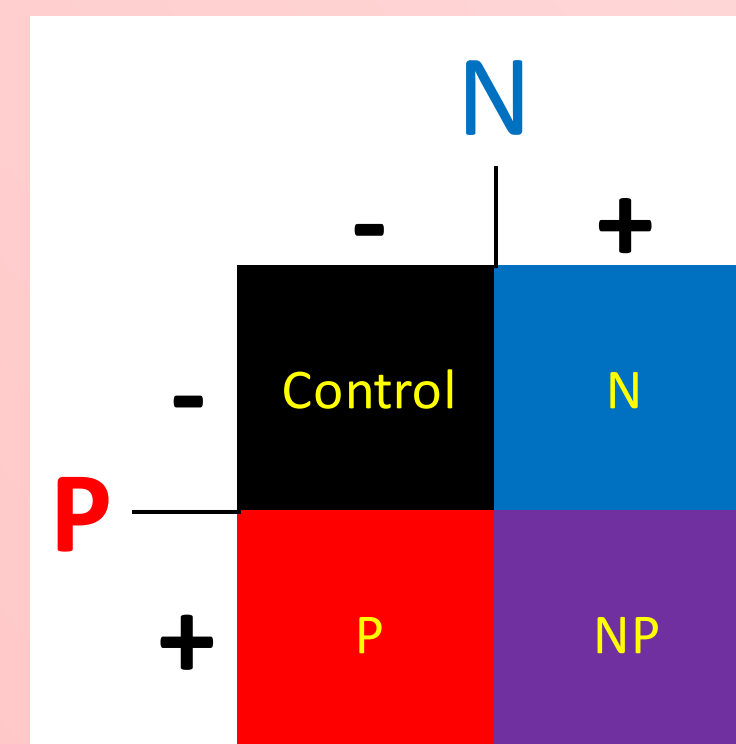


## Methods

Experimental plots have been fertilized with 10 kg/ha/yr  $\text{NH}_4\text{NO}_3$  and/or 30 kg/ha/yr  $\text{NaH}_2\text{PO}_4$  since spring 2011.

The canopy of twelve sugar maples (one tree in each treatment plot (4) in three stands) was accessed with rope and harness. A 20 ft pole pruner collected foliage, and sampling height was measured from the ground with ~5 sampling heights per tree.

Ten leaves per height were imaged for surface area then oven dried and weighed; three leaves were frozen for metabolic analysis.



The plots are arranged in N\*P factorial design (above). Dan Hong pipetting perchloric acid (below).



## Anatomy Results: Synergistic N+P response.

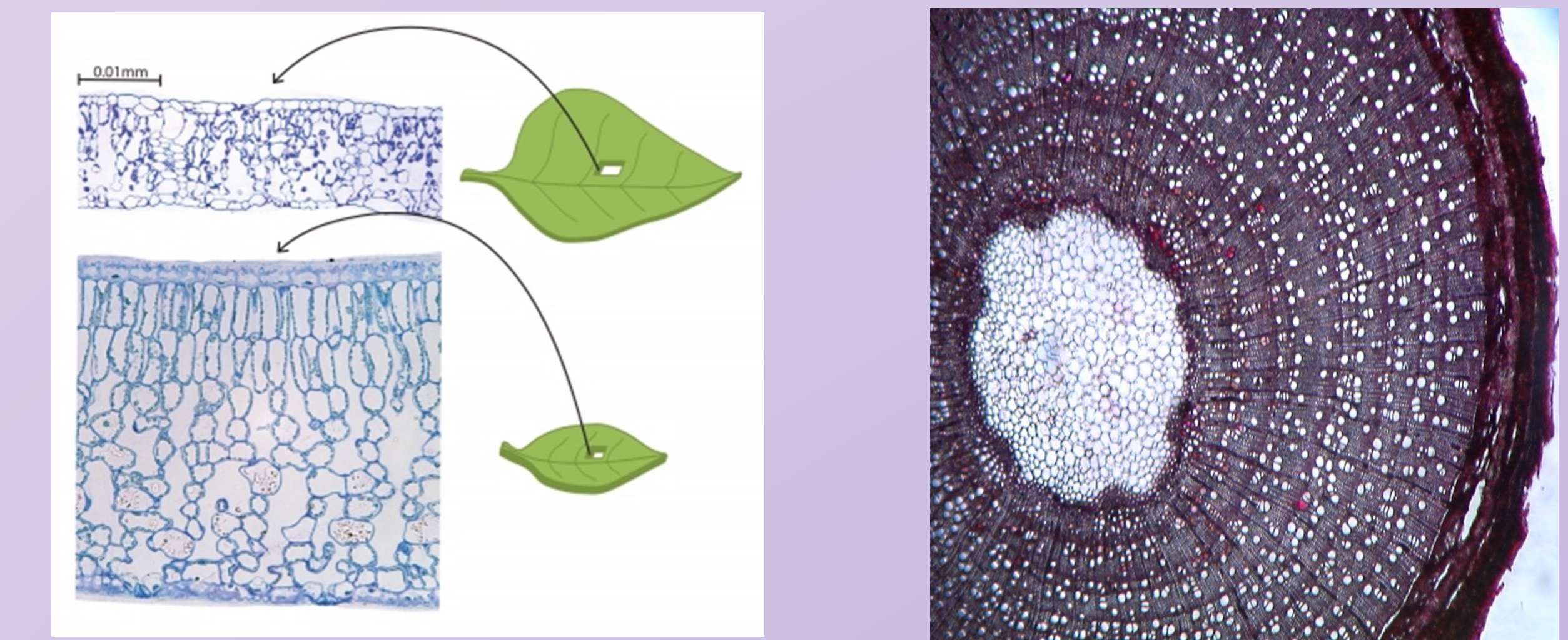
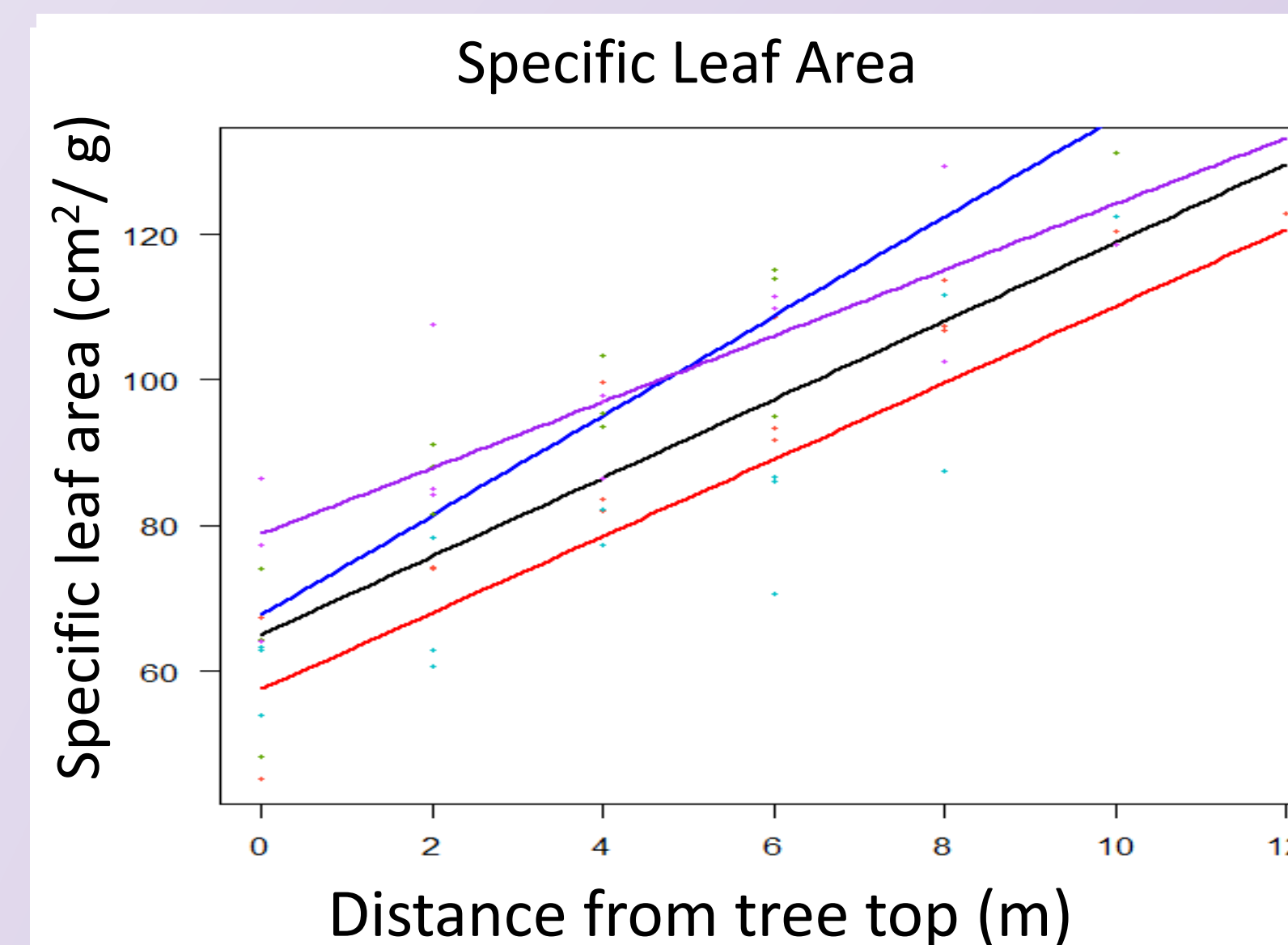
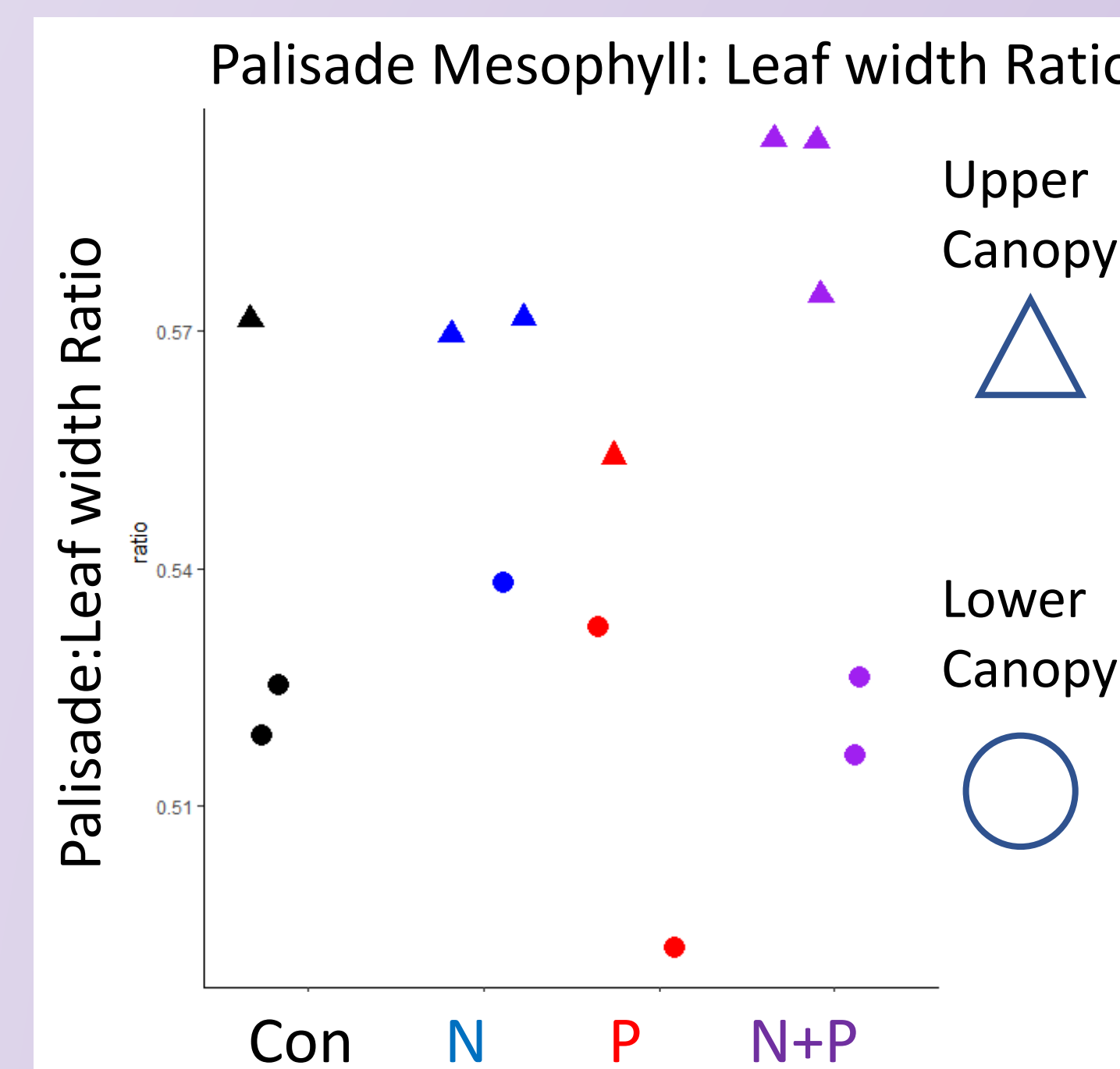


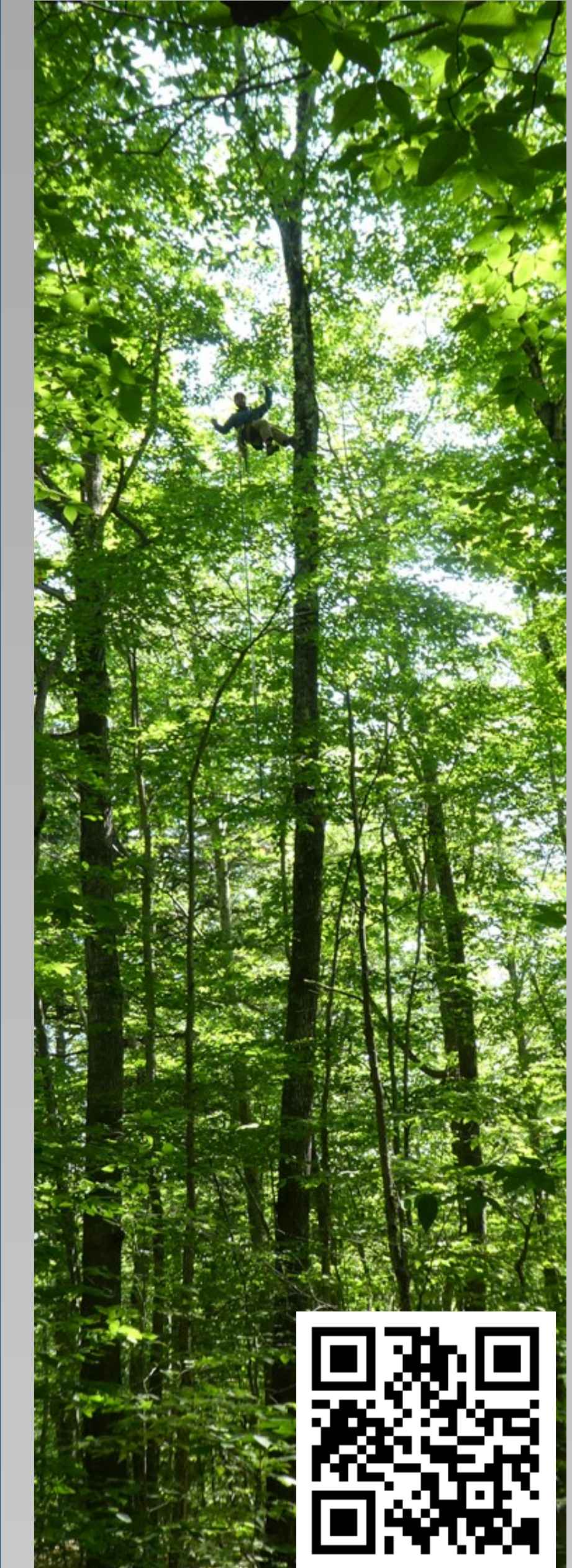
Diagram of shade and sun leaves, with corresponding mesophyll thickness (left). A cross section of a twig for future analyses (right).



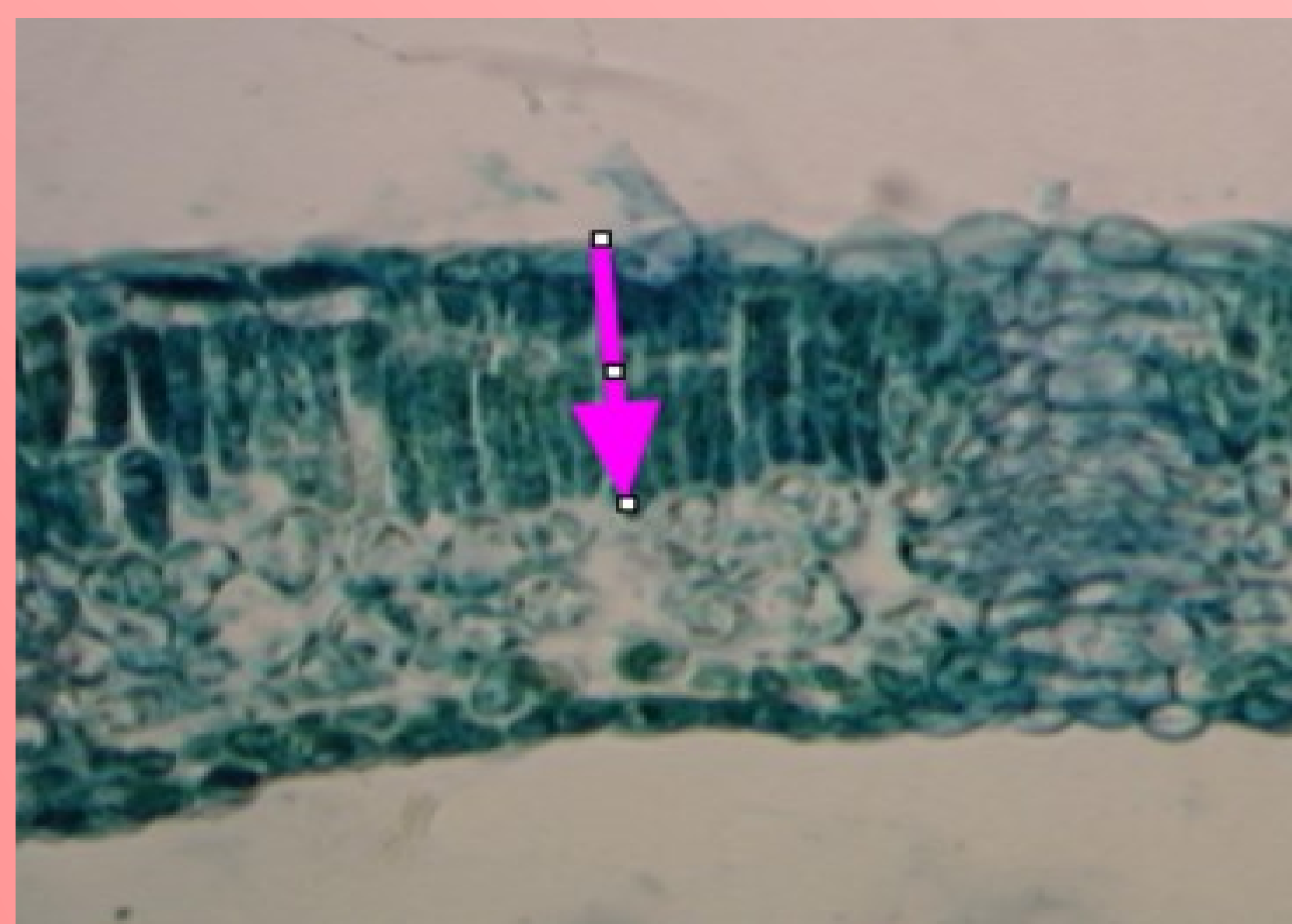
This project supported by NSF grant: #DEB-0949324  
Thank you MELNHE Field crew 2017!  
Photo credit: Gretchen Lasser, Claudia Victoroff

## Discussion

Sugar maple canopies respond to the gradient of light environment, and to nitrogen and phosphorus fertilizer. The increase in chlorophyll a, b, and total carotenoids in trees fertilized with Nitrogen may be explained by the amount of nitrogen needed to make these proteins. Interestingly, while the metabolite data suggest that phosphorus may not be involved in metabolite synthesis. However, the synergistic response (N+P) of both specific leaf area and palisade to leaf width ratio may suggest that sugar maple is phosphorus limited during leaf expansion, or cell membrane synthesis. Interestingly, specific leaf area increased with N+P treatment: leaves were less massive per unit area.



A releasable basal anchor for climber safety (above). Alex Young using sling-shot to get a line over a structural limb (below).



Sugar maple leaf anatomy with palisade mesophyll width indicated by arrow (above). Example leaf surface area measurement in ImageJ (right).

